UNIVERSITI SAINS MALAYSIA

First Semester Examination
2006/2007 Academic Session
Peperiksaan Semester Pertama
Sidang Akademik 2006/2007

October/November 2006
Oktober/November 2006

ESA 221/3 – Solid Mechanics
Mekanik Pepejal

Hour : [3 hours]
Masa : [3 jam]

INSTRUCTION TO CANDIDATES:
ARAHAN KEPADA CALON :

Please ensure that this paper contains **EIGHT (8)** printed pages and **EIGHT (8)** questions before you begin examination.
*Sila pastikan bahawa kertas soalan ini mengandungi **LAPAN (8)** mukasurat bercetak dan **LAPAN (8)** soalan sebelum anda memulakan peperiksaan.*

Part A: Answer **ALL** questions. Part B: Answer **FOUR (4)** questions.
*Bahagian A: Jawab **SEMUA** soalan. Bahagian B: Jawab **EMPAT (4)** soalan.*

Student may answer the questions either in English or Bahasa Malaysia.
Pelajar boleh menjawab soalan dalam Bahasa Inggeris atau Bahasa Malaysia.

Each questions must begin from a new page.
Setiap soalan mestilah dimulakan pada mukasurat yang baru.

PART A/*BAHAGIAN A*

1. A flat bar of cross-section 25mm by 90mm of length 1.75m elongates 3.55mm as the result of an axial load of 250kN. The proportional limit of the material is 300kN/m2. Determine the axial stress in the bar and the elastic modulus.

   Sebatang bar rata dengan keratan rentas 25mm x 90mm dan panjang 1.75m memanjang 3.55mm akibat daya paksi 250kN. Had berkadaran bahan ialah 300 kN/m^2. Peroleh tegasan paksi di bar dan modulus elastiknya.

   (6 marks/*markah*)

2. A flat bar of cross-section 30mm by 90mm of length 2.0m elongates 4.5mm as the result of an axial load. If the elastic modulus is 205 x 10^6 kN/m^2 and Poisson Ratio is 0.30 for the material, find the axial load and the total change in each cross sectional dimension.

   Sebatang bar rata dengan keratan rentas 30mm x 90mm dan panjang 2.0m memanjang 4.5mm akibat daya paksi. Jika modulus elastiknya ialah 205 x 10^6 kN/m^2 dan nisbah Poissonnya ialah 0.30. Untuk bahan tersebut, peroleh daya paksi dan pertukaran keseluruhan untuk setiap dimensi keratan rentas.

   (6 marks/*markah*)

3. A round steel rod shown in **Figure 1** has a diameter of 30mm

   *Sebatang rod bulat dalam **Rajah 1** mempunyai garispusat 30mm*

   (i) Determine the axial stress in the rod.

   Peroleh tegasan paksi dalam rod.

   (ii) The lengthening of the rod due to the load.

   Pemanjangan rod kerana beban.

   Assume E_s = 200 x 10^6 kN/m^2

   Andaikan E_s = 200 x 10^6 kN/m^2

PART B/*BAHAGIAN B*

4. A circular steel (G_s = 80 GPa) shaft and an aluminum (G_{al} = 28 GPa) shaft are attached and loaded as shown in **Figure 2**. Determine

*Satu aci keluli bulat (G_s = 80 GPa) dan aci aluminium (G_{al} = 28 GPa) disambung dan dibeban seperti ditunjukkan dalam **Rajah 2**. Dapatkan*

(a) the angle of rotation of section at D with respect to section at A.

sudut pusingan di bahagian D yang berkaitan dengan bahagian A.

(b) the torsional shear stress at point E.

tegasan ricih kilasan di titik E.

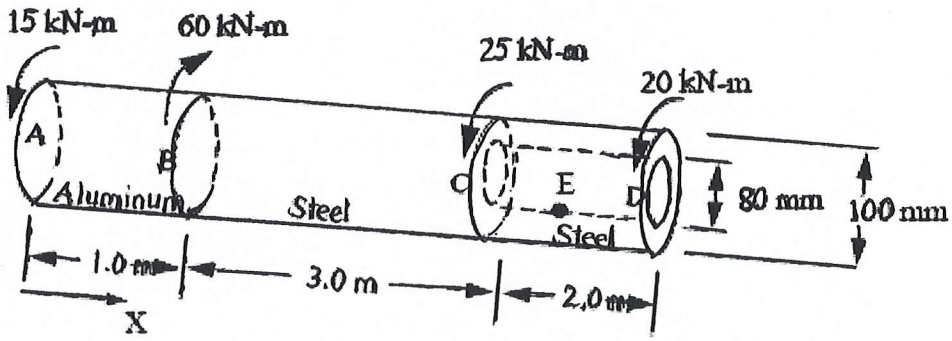


Figure 2/*Rajah 2*

(20 marks/*markah*)

5. The machine element shown in **Figure 3** is loaded in a plane of symmetry. Determine the principal stresses and maximum shearing stress at point A that is in the web just above the junction between the flange and the web. The second area moment of inertia about the neutral axis is $I = 94.5\times10^6$ mm^4.

Elemen Mesin yang ditunjukkan dalam ***Rajah 3*** *terbeban di dalam satah simetri. Tentukan tegasan utama dan tegasan ricih maksimum di titik A yang mana di dalam web hanya di atas simpang di antara rim yang terkeluar dan web. Keluasan kedua momen sifat tekun di paksi neutral ialah* $I = 94.5\times10^6$ *mm*^{4}.

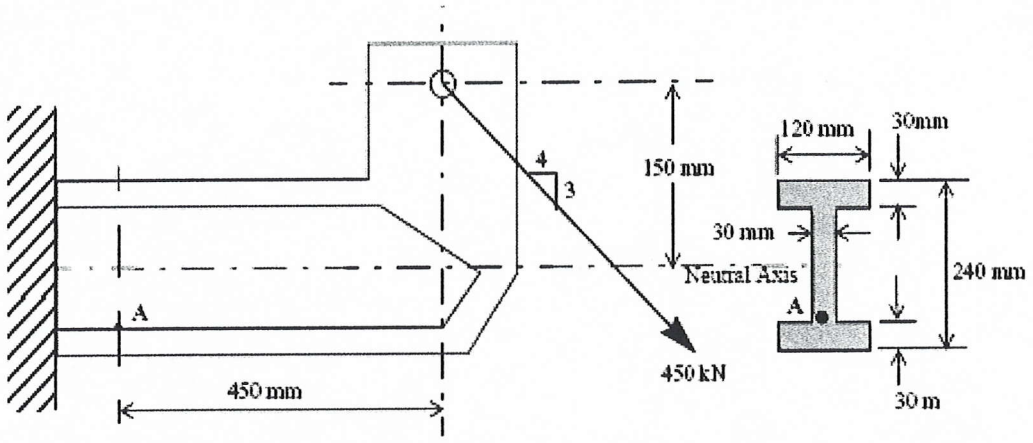


Figure 3/*Rajah 3*

(20 marks/*markah*)

6. Steel (E = 200 GPa and ν = 0.3) bars A and B have lengths of L_A = 2.8 m and L_B = 2 m and area of cross-sections of A_A = 40 mm^2 and A_B = 60 mm^2. Before the force P is applied there exists a gap of 0.0005 m between the rigid bar and bar B as shown. Due to the action of force P it was observed that point C moved by 0.0045 m in the direction of P. Determine

Bar-bar keluli(E = 200 GPa and ν = 0.3) A dan B panjang setiapnya L_A = 2.8 m dan L_B = 2 m mempunyai luas keratan rentas A_A = 40 mm^2 dan A_B = 60 mm^2. Sebelum suatu daya P dikenakan wujud ruang sebesar 0.0005 m di antara bar tegar dan bar B seperti yang ditunjukkan. Setelah pemerhatian dilakukan titik C telah bergerak sebanyak 0.0045 m dalam arah B disebabkan daya P. Tentukan

(a) the applied force P.

daya P yang dikenakan.

(b) the contraction of bar B.

pengecutan oleh bar B.

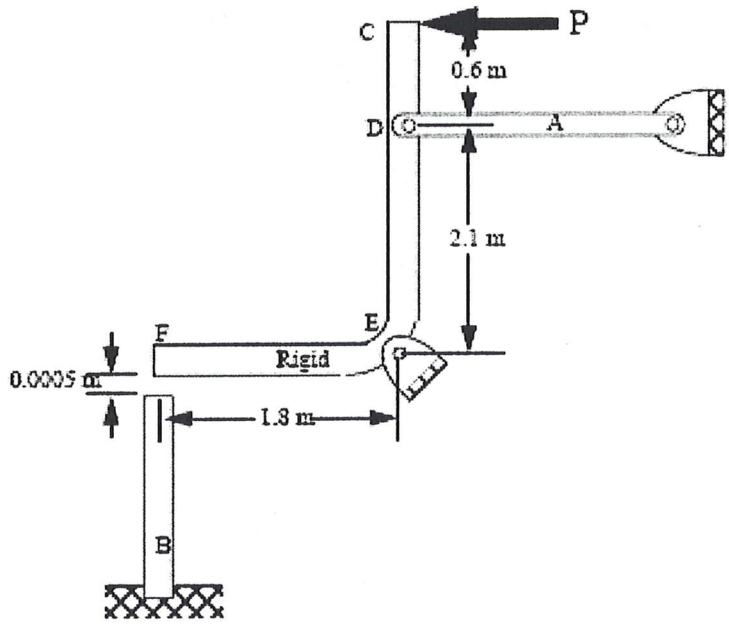


Figure 4/*Rajah 4*

(20 marks/*markah*)

7. The built-up wooden beam shown in **Figure 5** is subjected to a vertical shear of 10 kN. The nails are spaced longitudinally at A and B. If the expected shearing force in the nails at A is not greater than 300 N and at B is not greater than 500 N, determine

*Alur kayu terbina ditunjukkan dalam **Rajah 5** dikenakan ricih tegak sebanyak 10 kN. Paku-paku dijarakkan secara longitul di A dan B. Jika jangkaan daya ricih di dalam paku di A tidak melebihi 300 N and di B pula tidak melebihi 500 N, tentukan*

(a) I of the beam cross section.

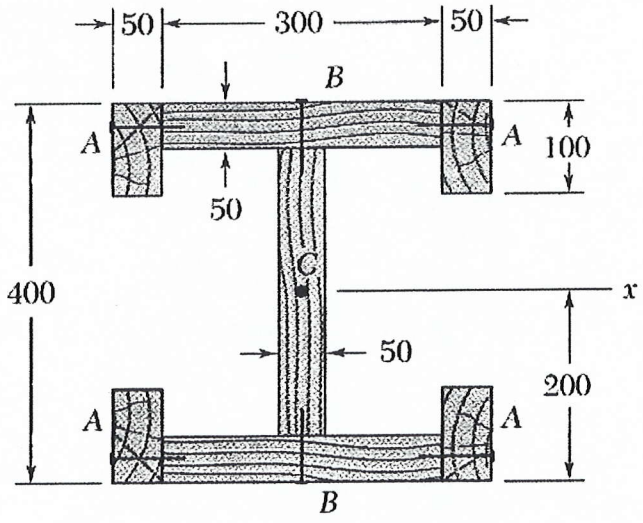
momen sifat tekun I, keratan rentas alur.

(b) space of the nails at A.

ruang paku di A.

(c) space of the nails at B.

ruang paku di B.



Dimensions in mm

Figure 5/*Rajah 5*

(20 marks/*markah*)

8. The hollow beam (E = 72 Gpa) has a uniform wall thickness of 8 mm and is subjected to an axial compression load P at the distance of 100 mm from the netral axis, as seen in the **Figure 6**. Determine

*satu alur kosong (E=72 GPa) mempunyai ketebalan dinding 8mm seragam dan dikenakan beban P mampatan paksi pada jarak 100mm dari paksi neutral seperti ditunjukkan dalam **Rajah 6**. carikan*

(a) the largest P that can be applied without exceeding the allowable stress of 135 MPa in tension and 180 MPa in compression.

beban P yang terbesar yang boleh diaplikasikan dengan tidak melebihi tegasan sebanyak 135 MPa dan mampatan sebanyak 180 Mpa.

(b) the corresponding radius of curvature of the beam.

radius yg sepadan dengan kelengkungan alur.

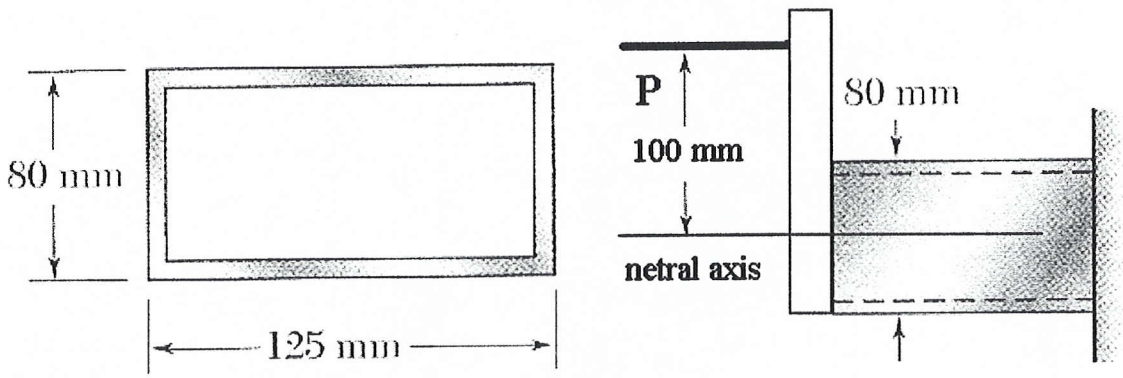


Figure 6/*Rajah 6*

(20 marks/*markah*)

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